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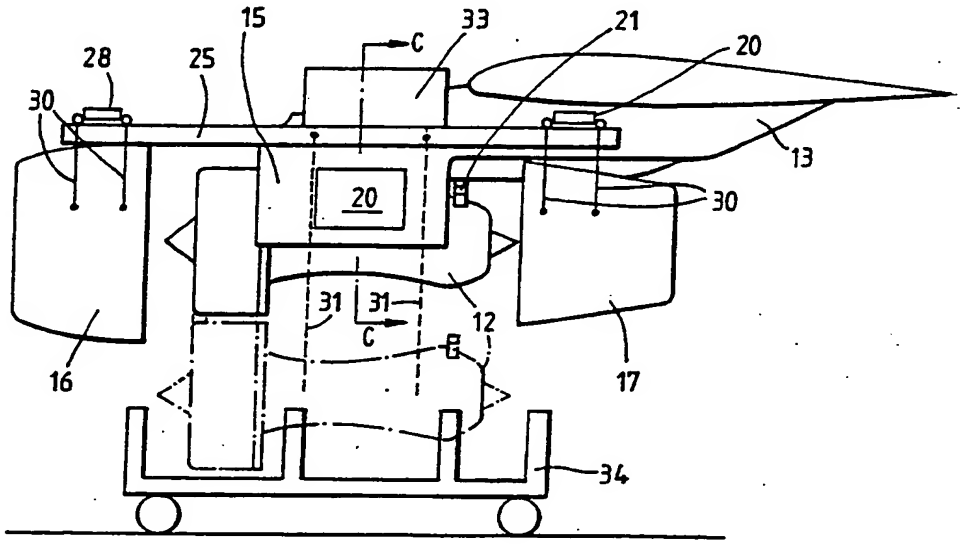
(54) Title: METHOD OF AND APPARATUS FOR REMOVING AND REPLACING A PART OR PARTS OF A GAS TURBINE ENGINE POWERPLANT



(57) Abstract

A method of and apparatus for the removal and replacement of part of a gas turbine engine powerplant (10). Two beams (25) are attached to the pylon (13) from which the powerplant (10) is suspended from an aircraft. Those parts of the powerplant (10) which are not required to be moved are suspended from carriages (28, 29) which are translatable along the beams (25) when the parts which are to be removed are disconnected from the remainder of the power plant (10). The carriages (28, 29) together with the parts which they carry are then translated to a position which permits the removal of the remaining parts. Replacement of the removed part is essentially the reverse of the procedures for parts removed. The method reduces the time taken to replace powerplant parts.

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METHOD OF AND APPARATUS FOR REMOVING AND REPLACING A PART OR PARTS OF A GAS TURBINE ENGINE POWERPLANT

This invention relates to a method of and apparatus for the removal and replacement of a part or parts of a gas turbine engine powerplant and in particular to such a powerplant mounted on an aircraft.

A common and convenient way of mounting a gas turbine engine powerplant on an aircraft is to suspend the powerplant from a pylon mounted on the underside of the aircraft wing. It is inevitable that at some time, a part or parts of the powerplant will have to be removed for repair or replacement. Frequently this involves the removal of the whole powerplant from the aircraft whereupon it is taken away for dissembly. Modern gas turbine engine powerplants are frequently built on a modular basis. If the particular problem with a powerplant is limited to a particular module or group of modules, it is clearly not efficient to remove all of the modules from the aircraft to solve the problem. It would be far more desirable to be able to remove the defective module or modules from the aircraft while leaving the remaining modules on the aircraft. This would enable only the defective module or modules to be replaced, thereby ensuring rapid re-entry into service of the aircraft.

It is an object of the present invention to provide a method of removing a gas turbine engine powerplant, or part thereof, from an aircraft and to its replacement which substantially avoids the aforementioned difficulties.

It is a further object of the present invention to provide apparatus for carrying out such a method.

According to the present invention, a method of removing and replacing a part of a gas turbine engine powerplant on an aircraft comprises the steps of temporarily attaching support structure to said aircraft at a position adjacent said gas turbine engine powerplant, attaching those parts of said powerplant which are not required to be removed from said aircraft to said support structure,

attaching those portions of said powerplant to be removed to a crane, hoist or the like, disconnecting from the remainder of said powerplant and said aircraft said powerplant parts to be removed so that the remaining powerplant parts are solely supported from said aircraft by said temporary support structure, removing said disconnected powerplant parts from said powerplant using said crane, hoist or the like, replacing said removed powerplant parts on said powerplant and connecting them thereto and to said aircraft, and subsequently removing said temporary support structure.

According to a further aspect of the present invention, apparatus for use in the removal and replacement of a part of a gas turbine engine powerplant mounted on an aircraft comprises support means for temporary attachment to said aircraft, means for attaching said support structure to those parts of said powerplant which are not to be removed and replaced, and a crane, hoist or the like for use in the removal and replacement of those parts of said powerplant which are to be removed and replaced.

The present invention will now be described, by way of example, with reference to the accompanying drawings in which:

Figure 1 is a side view of a gas turbine engine powerplant, part of which is removable in accordance with the method of the present invention.

Figure 2 is a view on section line A-A of Figure 1.

Figure 3 is a view on section line B-B of Figure 2.

Figure 4 is a perspective view of the gas turbine engine powerplant shown in Figure 1 indicating how part of the nacelle of the powerplant is pivotally mounted on the remainder of the nacelle.

Figure 5 is a side view of the gas turbine engine powerplant shown in Figure 1 in a partially dissembled state indicating the manner in which part of the powerplant is removable in accordance with the method of the present invention and showing apparatus in accordance with the present invention.

Figure 6 is a view on section line C-C of Figure 5.

Referring to Figure 1, a gas turbine engine powerplant generally indicated at 10 comprises a nacelle 11 which encloses a ducted fan gas turbine engine 12 (shown in interrupted lines). The powerplant 12 is suspended by means of a pylon 13 from an aircraft wing 14. The ducted fan gas turbine engine 12 is of conventional configuration. It will not, therefore, be described in any further detail.

The pylon 13 is likewise of generally conventional configuration. However a part 15 of the nacelle 11 is structurally integral with the pylon 13. Specifically the nacelle part 15 is a part of the upper half of the nacelle 11 which is located in the mid-region of the nacelle 11. It is of inverted generally u-shaped cross-section and interconnects the fully annular parts 16 and 17 of the nacelle 11 which define the powerplant intake and final nozzle. The intake 16 and 17 are attached to the nacelle part 15 by conventional bolted joints.

The lower half of the nacelle 11 immediately below the nacelle part 15 is interposed between but is not attached to the intake 16 and nozzle 17. The lower nacelle half 18 is constituted by two similar access doors 19, one of which can be seen in Figures 1 and 4. Each access door 19 is pivotally attached to the nacelle part 15 so that it can be pivoted away from the remainder of the nacelle 11, as can be seen in Figure 4 to provide maintenance access to the ducted fan gas turbine engine 12. Additionally, the access doors 19 are removable from the nacelle part 15 to facilitate at least partial powerplant removal in accordance with the method of the present invention.

Each of the access doors 19 and the nacelle part 15 is provided with a pivotable flap 20. During normal operation of the ducted fan gas turbine engine 12, the flaps 20 block correspondingly shaped apertures in the nacelle part 15 and the access doors 19. However when reverse thrust of the engine 12 is required for braking purposes, the flaps 20 pivot open. They pivot in such a way as to divert at least

some of the fan by-pass air passing through the engine 12 in a generally forwards direction.

It will be seen therefore that all of the nacelle 11 is either directly or indirectly carried by the pylon 13; the nacelle part 15 being structurally integral with the pylon 13 while the remainder of the nacelle 11 is carried by the nacelle part 15. None of the nacelle 11 is carried by the ducted fan gas turbine engine 12.

The ducted fan gas turbine engine 12 is supported within the nacelle 11 at four locations: one at the rear of the engine and three at the front.

The rear engine mounting 21 can be seen in Figure 3. It is of conventional configuration and interconnects the turbine casing of the engine 12 and the pylon 13.

The front of the engine 12 is supported by three mountings 22,23 and 24 which can be seen in Figure 2. The mountings 22 and 24 are located in a horizontal plane containing the longitudinal axis of the engine 12 and interconnect the fan casing of the ducted fan engine 12 with the nacelle part 15. The mounting 23 is located at the top of the fan casing and interconnects the fan casing with the pylon 13. The fan casing is the largest diameter part of the engine 12 and surrounds the engines' fan blades 25 visible in Figure 4.

All of the mountings 22,23 and 24 are of the same general type and, together with the rear mounting 21, are readily releasable to permit the removal of the engine 12 from the pylon 13.

It is sometimes necessary to remove and replace part of the powerplant 10. The present invention is concerned with a method of achieving this end without the total removal of the powerplant 10 from the pylon 13.

When it is desired, for instance, to remove and replace the ducted fan gas turbine engine 12 but not the intake 16 and nozzle 17, the following procedure is followed:

Two similar beams 25, which can be seen in Figures 5 and 6, are temporarily attached to the pylon 13.

Specifically one beam 25 is positioned each side of the pylon 13 so that the beams 25 are parallel with each other and located horizontally above the powerplant 10. The beams 25 are interconnected by a series of bars, one of which 26 can be seen in Figure 6, which pass through suitable bushes 27 provided in the pylon 13. The pylon 13 therefore supports the beams 25.

The beams 25 each carry two carriages 28 and 29. The carriages 28 and 29 are adapted to translate along their respective beams 25 and are provided with support cables 30. The support cables 30 are attached to the intake 16 and nozzle 17 so that the intake 16 is interconnected with the carriage 28 and the carriage 29 interconnected with the nozzle 17. The intake 16 and nozzle 17 are then disconnected from the nacelle part 15 and the carriages 28 and 29 translated to the positions shown in Figure 5 where they are clear of the engine 12.

The access doors 19 are then removed although it may be possible to merely pivot them to their fully open position. Four cables 31 (shown in interrupted lines in Figure 5 and also visible in Figure 6) are then attached to suitable lugs 32 on the engine 12. The cables 31 pass through apertures in the nacelle part 15 to be attached to a suitable winding mechanism 33 positioned on the beams 25. It will be appreciated however that different winding or hoist mechanisms could be employed if desired. Indeed it may be desirable under certain circumstances to employ a free-standing crane (not shown) which is not directly attached to the beams 25.

The engine mountings 21-24 are then disconnected to permit the engine 12 to be lowered by the winding mechanism 33 on to a suitable cradle 34 as shown in interrupted lines in Figure 5. The cables 31 can then be disconnected from the engine 12 to permit it to be taken away for repair or maintenance work.

A replacement engine 12 on a cradle 24 is then positioned immediately below the pylon 13 and the cables 31

attached to it. The engine is then raised by the operation of the winding mechanism 33 until it is appropriately positioned for its attachment by the mountings 21-24 to the nacelle part 15 and the pylon 13. The access doors 19 are then re-attached and the carriages 28 and 29 translated along the beams 25 to position the intake 16 and nozzle 17 for attachment to the nacelle part 15.

Following the attachment of the intake 16 and the nozzle 17 to the nacelle part 15 all the various services to the engine 12 are attached. Finally the beams 25, together with the carriages 28 and 29 and the winding mechanism 33 are removed from the pylon 13.

It will be appreciated that under other circumstances, it may be desirable to remove only part of the gas turbine engine 12. Thus for instance, it may be desirable to remove the core of the engine 12, but not its fan assembly. Under these circumstances, the engine fan assembly would be supported from the beams 25 together with the intake 16 and nozzle 17 while the engine core is removed.

It will be readily apparent to those skilled in the art that other powerplant parts could be removed whilst leaving the remainder effectively attached to the pylon 13.

It will be seen therefore that the method of the present invention facilitates the rapid replacement of gas turbine engine powerplant parts without the time and expense involved in removing the whole powerplant from the aircraft upon which it is mounted.

Although the present invention has been described with reference to a particular type of powerplant mounting, it will be apparent that it is also applicable to powerplants with different types of mounting.

Claims:-

1. A method of removing and replacing a part of a gas turbine engine powerplant (10) on an aircraft structure (13) characterised by the steps of temporarily attaching support structure (25) to said aircraft structure (13) at a position adjacent said gas turbine engine powerplant (10), attaching those parts of said powerplant (10) which are not required to be removed from said aircraft structure (13) to said temporary support structure (25), attaching those portions of said powerplant (10) to be removed to a crane, hoist or the like (33), disconnecting from the remainder of said powerplant and from said aircraft structure (13) said powerplant parts to be removed so that the remaining powerplant parts are solely supported from said aircraft structure (13) by said temporary support structure (25), removing said disconnected powerplant parts from said powerplant (10) using said crane, hoist or the like (33), replacing said removed powerplant parts on said powerplant (10) and connecting them thereto and to said aircraft structure (13) and subsequently removing said temporary support structure.

2. A method of removing and replacing a part of a gas turbine engine powerplant as claimed in claim 1 characterised in that said powerplant parts which are not required to be removed from said aircraft structure (13) are translated to positions which permit the removal and replacement of the remainder of said powerplant parts, said temporary support structure (25) including means (28,29) to facilitate such translations.

3. Apparatus for use in the removal and replacement of a part of a gas turbine engine (10) powerplant mounted on an aircraft structure (13) characterised in that said apparatus comprises support means (25) for temporary attachment to said aircraft structure (13), means (28,29) for attaching to said temporary support structure (25) those parts of said powerplant (10) which are not be removed and replaced, and a

crane, hoist or the like (33) for use in the removal and replacement of those parts of said powerplant (10) which are to be removed and replaced.

4. Apparatus as claimed in claim 3 characterised in that said temporary support structure (25) comprises at least one beam.

5. Apparatus as claimed in claim 4 characterised in that said at least one beam (25) is adapted to be temporarily attached to a pylon (13) which supports said gas turbine engine powerplant (10).

6. Apparatus as claimed in claim 4 or claim 5 characterised in that one or more carriages (28,29) are mounted for translation along said beams (25), said one or more carriages (25) being adapted to support said parts of said powerplant which are not to be removed and replaced and translate those parts to positions which permit the removal and replacement of the remainder of said powerplant parts.

7. Apparatus as claimed in any one of claims 3 to 6 characterised in that said crane, hoist or the like (33) is mounted on said support structure (25).

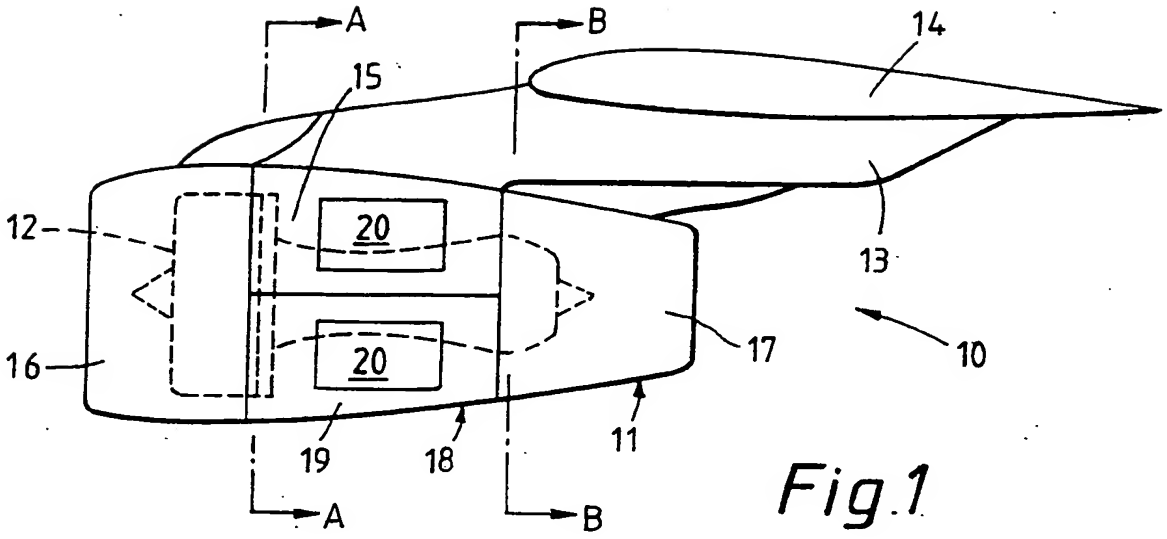

Fig.1

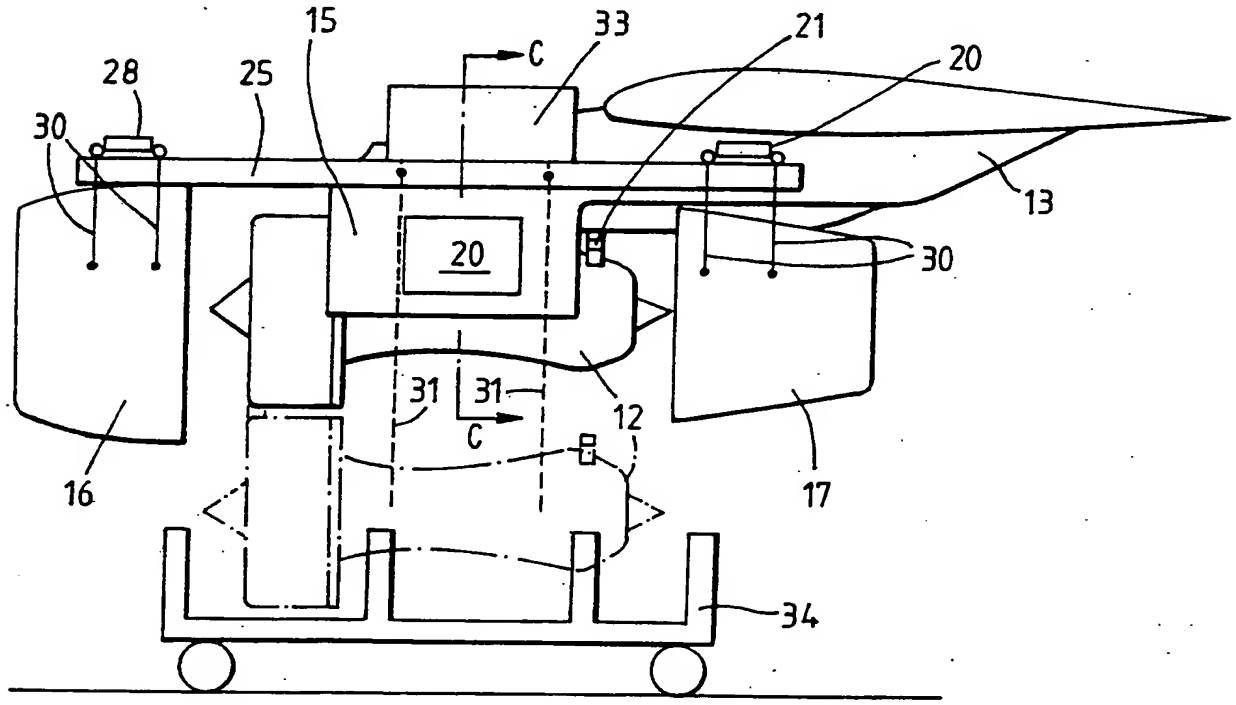

Fig.5

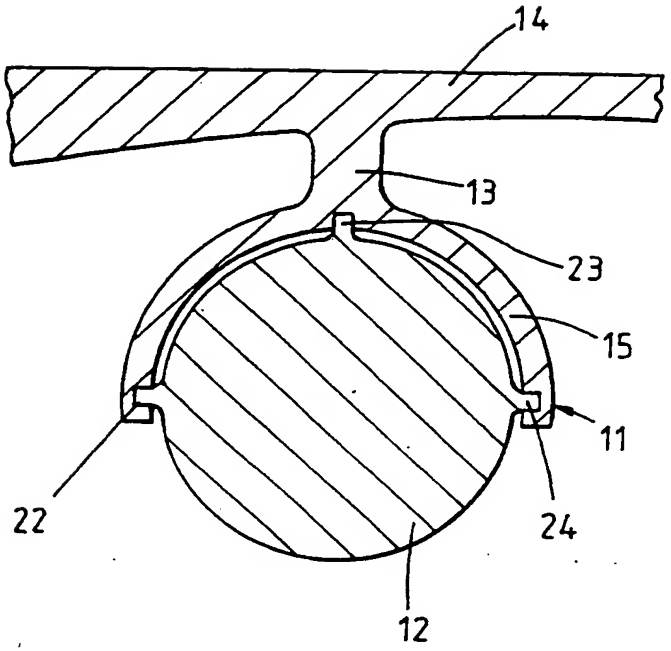

Fig.2

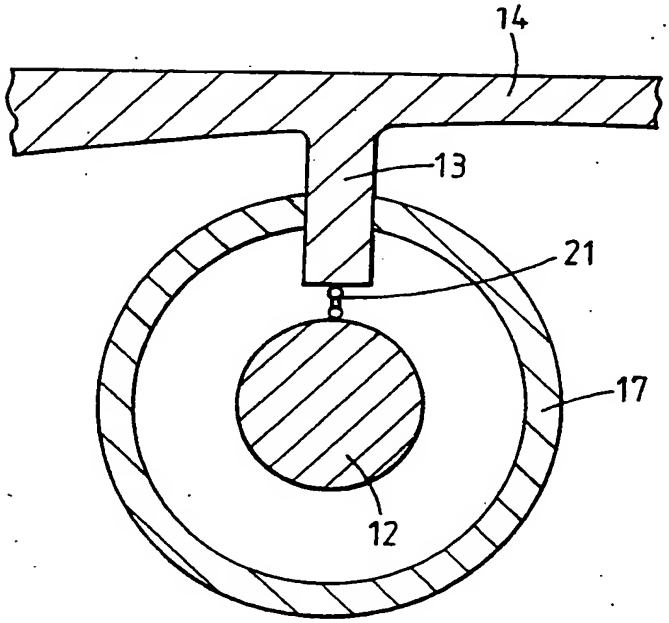

Fig.3

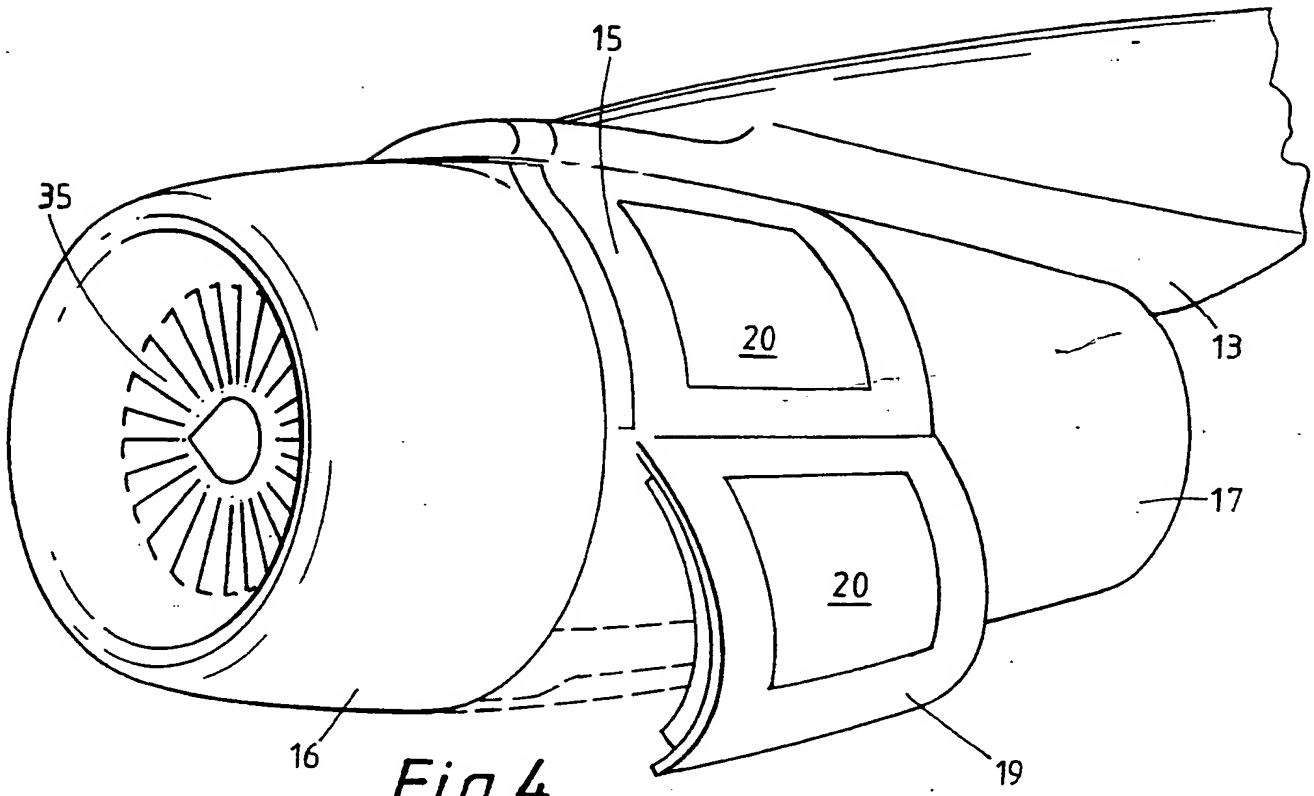

Fig.4

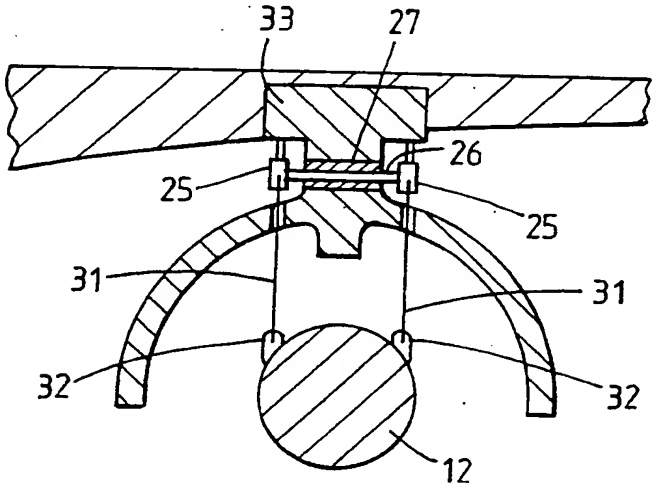

Fig.6

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 92/01369

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 B64F5/00

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	F01D ; B64F ; B64D ; F02C F02K

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
Y	FLIGHT INTERNATIONAL vol. 98, no. 3217, 5 November 1970, LONDON pages 708 - 714 P. MIDDLETON 'RB.211: transatlantic bridgehead' *Page 714: Figure legend for "top-right". Top-right figure*	1-7
Y	FR,A,2 455 547 (THE BOEING COMPANY) 28 November 1980 see page 30, line 13 - line 31 see figures 21-22	1-7
A	GB,A,2 069 427 (BRITISH AEROSPACE PLC.) 26 August 1981	

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
05 OCTOBER 1992	19. 10. 92
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	CRIADO Y JIMENEZ, F.

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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	GB,A,2 151 995 (SOCIETÈ ANONYME BELGE D'EXPLOTATION DE LA NAVEGATION AERIENNE SABENA) 31 July 1985	

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 9201369 SA 62506

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
FR-A-2455547	28-11-80	None		
GB-A-2069427	26-08-81	None		
GB-A-2151995	31-07-85	US-A-	4555078	26-11-85
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